the necessity, of establishing a governmental bureau for investigating and reporting upon the efficiency of the machines and tools that are used by the farmers. The need of such an institution is now felt all the more as a safeguard against imposition in connection with these proposed new motors and new methods of manufacturing power out of nothing.

DUST WHIRLS AND FAIRY DANCES.

Mr. O. C. Pepoon, of Medicine Lodge, Barber County, Kans., sends the following description of a dust whirl observed at that place in the summer of 1897:

In the summer of 1897, the exact date is forgotten, at about 3 p. m., I noticed a whirlwind moving from the northwest to the southeast. It was in every way similar to an ordinary whirlwind, including the straight wind which accompanied it, except that instead of one circular wind five small whirlwinds whirled around a common centre. Each whirlwind resembled an ordinary whirlwind in form and velocity. They whirled on their individual axes, also on their common axis to the right. The whirlwinds were about 15 feet high.

The day was clear, warm, and still, with occasional gusts, from different directions generally westerly. The whirlwind was first seen at the northwest corner of a field of last year's stubble, at the north end of an 8-foot osage orange hedge, running south.

The whirlwind ran a few rods and vanished.

The diagram accompanying this article by Mr. Pepoon shows that the system of little whirls revolving about a common center was formed on the leeward side of the hedge to which he refers. These whirls were undoubtedly due in part to the presence of the hedge, since similar whirls are encountered in the rear of every obstacle. But they were also due in part to the hot, dry surface of the ground, since every small mass of air that is heated hotter than its neighbor rises and carries the lightest dust with it. Pictures of similar and many other forms of dust whirls are given in the volume of plates accompanying the work on Whirlwinds and Duststorms of India by P. F. H. Baddeley, London, 1860. He gives diagrams showing several dust whirls rushing along one after the other until finally all combine into one large whirl; or again, a group of thirty or forty whirls forming a continuous series like the front of an advancing squad of soldiers, or even circling around a central region like the outside boundary of a tornado. His diagrams suggest that in some cases a circle of dust storms, representing ascending whirls, incloses an area in which the air is descending, but this may be a hypothesis of the author and not the result of actual observation. Baddeley was a very enthusiastic student of the subject, and followed these whirls on horseback or in a buggy, note book and pencil in hand, noting and sketching as he went along. He attributes to electrical action the phenomenon that we believe can easily be explained without electricity as being due simply to the wind and the heat. He says that:

Dust whirlwinds are common in all parts of India, especially during the dry season. Sometimes a slender lofty cylindrical pillar of dust is seen revolving on its axis, or several such pillars moving on together in the same direction, or revolving in a circle, or as a dense cloud of dust sweeping over the country like a tornado, the cloud of dust occasionally presenting to the view a distinctly columnar structure. In northern India the smaller whirlwinds appear in dry, windy weather. They occur with singular regularity during the middle of the day. Sometimes a slowly-moving whirlwind instead of appearing as a simple column is found to be composed of several distinct vortices, each one rotating on its axis as it revolves around in the whirling circle. Each separate vortex has attached to it a fan-shaped train of dust.

This remarkable sight gives the idea of a fairy dance round a ring, and the motions are, from all accounts, exactly imitated by the dancing Dervishes of Turkey, one of their holy exercises being to whirl round and round like a top, singly, or in company with several others, performing at the same time a gyration round in a circle, as if their dance originated in the very phenomenon now described. We may sometimes watch this motion for a length of time without changing our position more than a few yards.

Mr. Baddeley says that—

The essential portion of the whirlwind always appeared to him as a lofty cylindrical pillar preserving apparently the same diameter throughout its entire height for thousands of feet. A dust storm or tornado is occasioned by an accumulation of whirlwind columns moving en masse or in rapid succession over the earth's surface in a direct or wavy line. Thousands of these spiral columns pass by in one direction during six or seven hours of the hottest portion of the day, and on other days repass in another direction as if a host was mustering for battle.

Among the numerous details given by Baddeley, we quote the curious fact stated by him:

Birds, such as kites and vultures, are often seen soaring high up just above and around these dust whirlwinds, following them for some distance, soaring about and around them, diving at each other as if in sport, keeping pace with them, seemingly with no other purpose than that of enjoyment.

The reader will find a very interesting description of mechanical methods of forming whirling columns of air with the attending dust whirls and waterspouts in a French work on Tourbillons, by Weyher. The method adopted by him consists in placing a wheel or fan at some distance above a basin of water or table covered with dust. The rapid horizontal rotation of the fan sets all the air of the room in motion, producing a spiral ascending whirl over the table, having a crude resemblance to a dust whirl, waterspout, or tornado.

Much more natural imitations of the atmospheric dust whirls have been made and described by Vettin in the Annalen für Physik und Chemie for 1856 and 1857. Experiments of this kind have lately been carried out quite perfectly by one of America's most skillful experimentalists, Prof. R. W. Wood, of Madison, Wis. (See an article by him entitled Some Experiments on Artificial Mirages and Tornadoes, L. E. D. Phil. Mag., April, 1899, Vol. XLVII, p. 349.) Professor Wood uses flat metal plates about a yard long and a foot wide covered with a little sand. By heating the plates the air above the sand becomes warmed and produces mirage effects; but when heated still hotter most beautiful little whirlwinds of rising hot air can be seen running about over the surface and carrying up the fine silica powder that is scattered upon the plate. When sal ammoniac is used instead of silica, dense clouds of white vapor immediately arise, and he has observed a most perfect miniature tornado of dense smoke about two yards high.

The preceding notes suffice to show how eddies and whirls of dust are formed on the hot plains of Kansas. It seems natural to infer that special combinations of winds and temperature may give rise to the large whirls or waterspouts and tornadoes, but we think it more likely that the latter have an analogous but slightly different origin. The solar rays that heat the ground on a clear day have an effect analogous to that of those rays that are stopped by the clouds in ordinary weather. In the formation of a waterspout, it is quite common to see its slender axis form at the base of a cloud and descend toward the sea level. This has been properly explained by Ferrel, who showed that the velocity of gyration can easily be very much greater high above the earth's surface than lower down, and that the cloud that is formed in the region of low pressure along the axis of the whirl must begin at the upper end of the waterspout and grow downward. The whirls in both waterspouts and tornadoes are, therefore, explained mechanically as originating in the clouds and extending downward, under favorable conditions, to the earth's surface. It is only the small dust whirls that originate at the earth's surface and only in rare cases do these extend upward to the clouds.

MONTHLY CHARTS FOR THE WEST INDIES.

We are pleased to be able to present in the accompanying charts, XII and XIII, a first attempt to draw monthly iso-

bars and isotherms for the West Indies, the Caribbean Sea, and the Gulf of Mexico. Probably the most interesting station on this chart is that of Colon, at which point the observations give us clear evidence that the equatorial belt of low pressure on the Pacific Ocean here crosses over into the Caribbean Sea. There can be no doubt but that the flow of northerly winds over the United States is often due as much to a deficiency of pressure in the Caribbean Sea or in Brazil as to an excess of pressure in North America. The study of the equatorial regions is certainly quite as important to the meteorologist as the study of the polar regions, a phase of the question that was especially dwelt upon in 1881 when discussing the necessity of the great international polar work. It is to be hoped that the publication of these charts, which have been kindly prepared by Mr. A. J. Henry, will prove of great service in attracting attention to the meteorology of this portion of the globe. We have on many occasions explained in the MONTHLY WEATHER REVIEW how this eastern end of the Pacific trough of low pressure turns northward in the summer season and reaches into Arizona. In that Territory, as at Colon, the low pressure is not a direct result of local temperature, but is a feature that belongs to the general circulation of the atmosphere.

Beginning with the month of March we hope to be able to complete the western portion of this map by making use of the data published on the daily and monthly maps of the Mexican service.

THE AMERICAN METEOROLOGICAL JOURNAL.

The Editor has received from one of our voluntary observers, a request for Vol. I, No. 1 of the American Meteorological Journal, and not being able to supply this number, takes the liberty of making this request known, in hope that some one may have a copy to spare.

The librarian of the Weather Bureau would like to obtain Nos. 1, 2, and 3 of Vol. II.

Prof. H. A. Hazen would like to obtain a personal copy of Vol. II, No. 2.

In general, copies of Volumes IX–XII may be purchased of the publisher by those who wish to complete their sets.

VERTICAL TEMPERATURE GRADIENTS.

Mr. J. S. Hazen, voluntary observer at Springfield, Mo., notes a remarkable difference of temperature within 90 feet of the ground at that place on March 26. He says:

The station thermometer is located in its shelter, 90 feet above an extra thermometer, which latter was 3 feet above a level lawn. The following comparative readings were taken:

Time.	Thermometer.		
	In shelter, 93 feet above lawn.	3 feet above lawn.	Difference.
	°	°	°
9 a.m.	32.2	36.5	4.3
10 a.m.	33.0	37.4	4.4
11 a.m.	33.0	37.7	4.7
12 a.m.	33.3	38.5	5.2
1 p.m.	33.5	38.9	5.4
3 p.m.	35.0	40.6	5.6
4 p.m.	34.2	39.0	4.8
5 p.m.	34.0	35.1	1.1

The observer's attention was first called to the peculiar condition by noticing that the trees and various other objects were covered with a heavy coating of ice down to about twenty feet from the ground, while the lower branches of the trees and the surface of the ground was entirely free from any evidence of ice.

The night of the 25–26th was cloudy, with light fog early in the the morning and the day following. The humidity was high, and the air impressed one as being damp, heavy, and penetrating.

Two thunderstorms of slight intensity occurred during the 26th, one shortly before 11 a. m., and the other about 2 p. m., and both were accompanied by hail. The hailstones were about the size of peas.

The line of demarcation between the warmer surface air and colder air above was sharply and distinctly drawn, but the colder air gradually encroached upon the warmer body of air. It was noted that during the first hailstorm the ice remained in the sloping gutter of a shed roof down to about twenty feet above the ground, but after the second storm the ice was extended down to within less than ten feet from the surface of the ground, while lower than that no ice remained.

It is believed from the amount of ice on the trees that the temperature was probably lower at a height of about fifty feet from the ground than it was in the instrument shelter, but there was no way of taking the temperature at that elevation. Ice began to form on the ground shortly after 8 p. m.

It has been suggested that—

If the air at the surface of the ground was unusually dense, by reason of pressure and humidity, still the cold brisk breeze a hundred feet above the ground would force a mixture between the cold air above and the warm air below in a very short time. It is, therefore, considered by some as remarkable that the colder air above should have encroached so gradually upon the warm air below.

The Editor would remark that the question is not one of pressure or humidity but of temperature, and that our first consideration must be to ascertain the relative reliability of the observed temperatures at 3 and 93 feet, respectively, above the lawn. On this point a letter of inquiry was immediately addressed to the observer who replied:

The temperature was obtained from a standard Weather Bureau thermometer, which was attached to a small stake, driven into the ground. There was no covering or obstructions around the thermometer, but as the weather was densely cloudy, the exposure was deemed good. There was a clear lawn space around the instrument of at least 50 feet.

As this exposure of a thermometer is wholly unsatisfactory, it would be improper to attempt to draw any refined conclusions from the comparison of the upper and lower temperatures.

When questions of a few degrees Fahrenheit are propounded in meteorology, the method of determining the temperature of the air is of paramount importance. Every one who has examined the subject now recognizes the fact that a thermometer does not show the temperature of the air unless all injurious radiation has been annulled either by protecting screens or by a rapid flow of air, or by the rapid whirling of a thermometer. In the present case, it is quite plausible that the temperature at the level of the lawn between 9 a. m. and 5 p. m. was higher than at the level of the instrument shelter 93 feet above the lawn, but the amount of this difference in degrees can not be satisfactorily deduced from these observations. It is not likely that the true difference was very large because, as the observer states, the weather was densely cloudy. The only way in which this difference could be determined with an accuracy of one-half a degree Fahrenheit, would be by using standard thermometers at the upper and lower station, well screened against all radiations, and well ventilated either by the natural wind or by whirling them, as with a sling psychrometer, or by causing a rapid indraught as in the Assman psychrometer. A full description of the various methods of determining the temperature of the air is given in the Editor's Treatise on Meteorological Apparatus and Methods, published as Part 2 of the Annual Report of the Chief Signal Officer for 1887. Recent special investigations have been published by the Seewarte at Hamburg and the Meteorological Office at Berlin.

Errors of several degrees Fahrenheit are liable to be incurred when a thermometer is simply hung in the open air without protection from radiation and without special ventilating currents. In the present case if the trees and other objects twenty feet above the ground were covered with ice and the sun's rays did not penetrate through the thick clouds, we should naturally expect that streams of cold air from the ice would settle down to the ground, and that the temperature at 3 feet above the lawn would be as cold, if not colder, than